

Origins of Agriculture Revolution or Evolution?

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What is Agriculture?

- ***Cultivation:***
 - Manipulation of populations of plants and animals in such a way as to control **distribution** and **yield**.
- Both of these characteristics often lead to ***domestication:***
 - human creation of a new form of plant or animal (the genetic outcome of selective cultivation/breeding to improve yield.)

What is Agriculture?

- Domestication in turn creates changes in the reproduction of these species, making them ultimately **dependent** on human manipulation to reproduce.
 - E.g., markers of seed domestication include larger seeds and thinner seed coats.

What is Agriculture?

- Human populations in turn often become dependent on domesticates, so we can say a full agricultural economy is one in which a ***co-dependency*** has emerged between plants animals and people.

Origins of Agriculture?

- Search for origins is often a fruitless concept ... it is **process** of domestication that we want to expose. Still we often speak of a search for the Origins of Agriculture.
- Important to recognize the process of domestication is a natural outgrowth of common hunting and gathering activities, BUT that it has a consequence that fundamentally alters human subsistence, settlement, and often social organization.

Likely Domesticates:

- **Plants**

- Common forager targets
- Generalists with wide habitat tolerance
- Reproductive organs able to withstand storage
- High mutation rates



Stands of the annual teosinte *Zea mays* subsp. *parviglumis* growing in luxuriant hillside settings in the state of Jalisco, Mexico.

Likely Domesticates:

- **Animals**
 - Hardy
 - Tamable
 - Comfort loving
 - Economically useful
 - Ready breeders
 - Easy to tend



Why is Agriculture Interesting?

- Importance for **evolution of complex societies** (“civilization”, states, empires)
- Important implications for understanding **human-environmental interaction** and **human impacts**
- Agriculture is often regarded as a crowning achievement of **human inventiveness**. (Does this make sense?)

Issues to Ponder

- 1. In what ways does farming represent a revolutionary **ADVANCEMENT** in cultural evolution? Is it **PROGRESS**?**
- 2. Who benefits with the origins of agriculture? In what ways?**
- 3. Compare individual benefits to group benefits.**

Advantages of Controlling Resource life cycles

1. Hunter-gatherers respond to subsistence variability by mobility and sharing or developing storage.
2. Cultivation increases predictability in space and time (tending field of seed crops, etc.).
3. Domestication can increase yields (bigger seeds, less loss on harvest, more accessible nutritious parts)
4. High yields and storage can help weather seasonal shortfalls and bad years.
5. Consistent food supply = reduced premature mortality (esp. infants) and increased fertility. (leads to population growth.

Disadvantages of Controlling Resource Life Cycles

1. “Tethering” to domesticates reduces adaptive flexibility.
2. Lower mobility and larger populations create conditions for increased disease. Pastoral animals are sources of disease.
3. Agricultural diets are often less nutritious (cheap calories). Health declines with the origins of Agriculture... in general.
4. High yields and storage can help weather seasonal shortfalls and bad years.

Competing Models for the Origins of Agriculture

1940s-1970s

PUSH vs. PULL Models

V. Gordon Childe

- Old World “Origin of Civilizations”
- “Neolithic Revolution”
Agriculture seen as the root cause of urbanization and social complexity



V. Gordon Childe

- Oasis Hypothesis
 - Increased aridity would have forced people, plants and animals to occupy confined areas around oases in the desert.
 - Symbiotic relationships would result.

Push Model – Change following adaptation to crisis

Robert Braidwood



Robert Braidwood of the Oriental Institute, University of Chicago, who pioneered the archaeological search for the origins of agriculture in the 1950s.

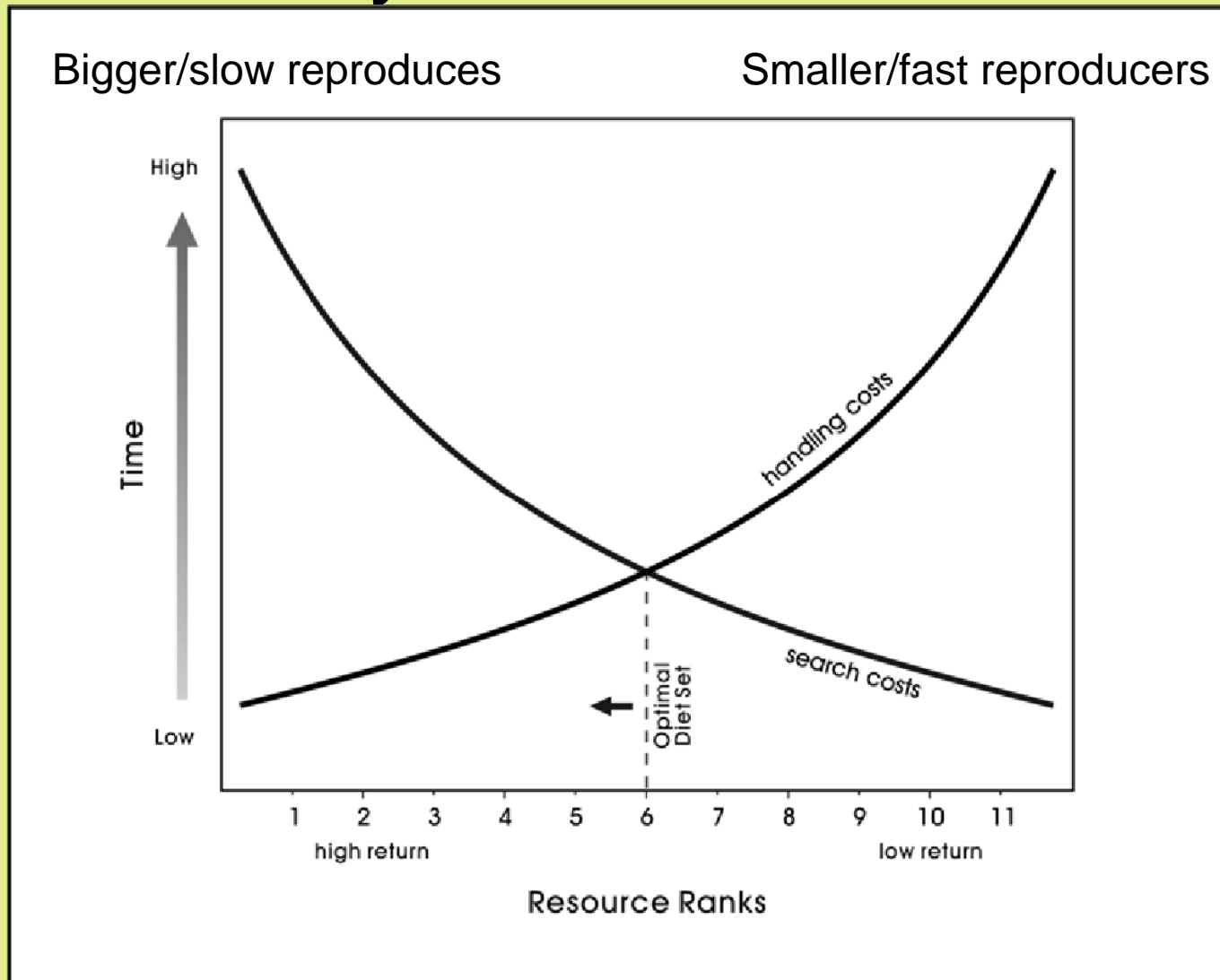
- Predicted that origins should have occurred where hunter-gatherers and wild ancestors of domesticates can be found.
- Engaged inter-disciplinary teams (archaeologists, botanists, geologists)



Kent Flannery's Broad Spectrum Revolution

- **Under periods of increased subsistence strain (e.g., end of the last ice age), people should take a greater variety of wild foods into diet.**
- **This Broad Spectrum diet would lead hunter-gatherers to manage wild species and eventually domesticate those most amenable.**
- **Experimentation with wild populations to reduce Risk and Uncertainty could lead to changes in the human-plant-animal interaction.**

Behavioral Ecology's Prey Choice Model

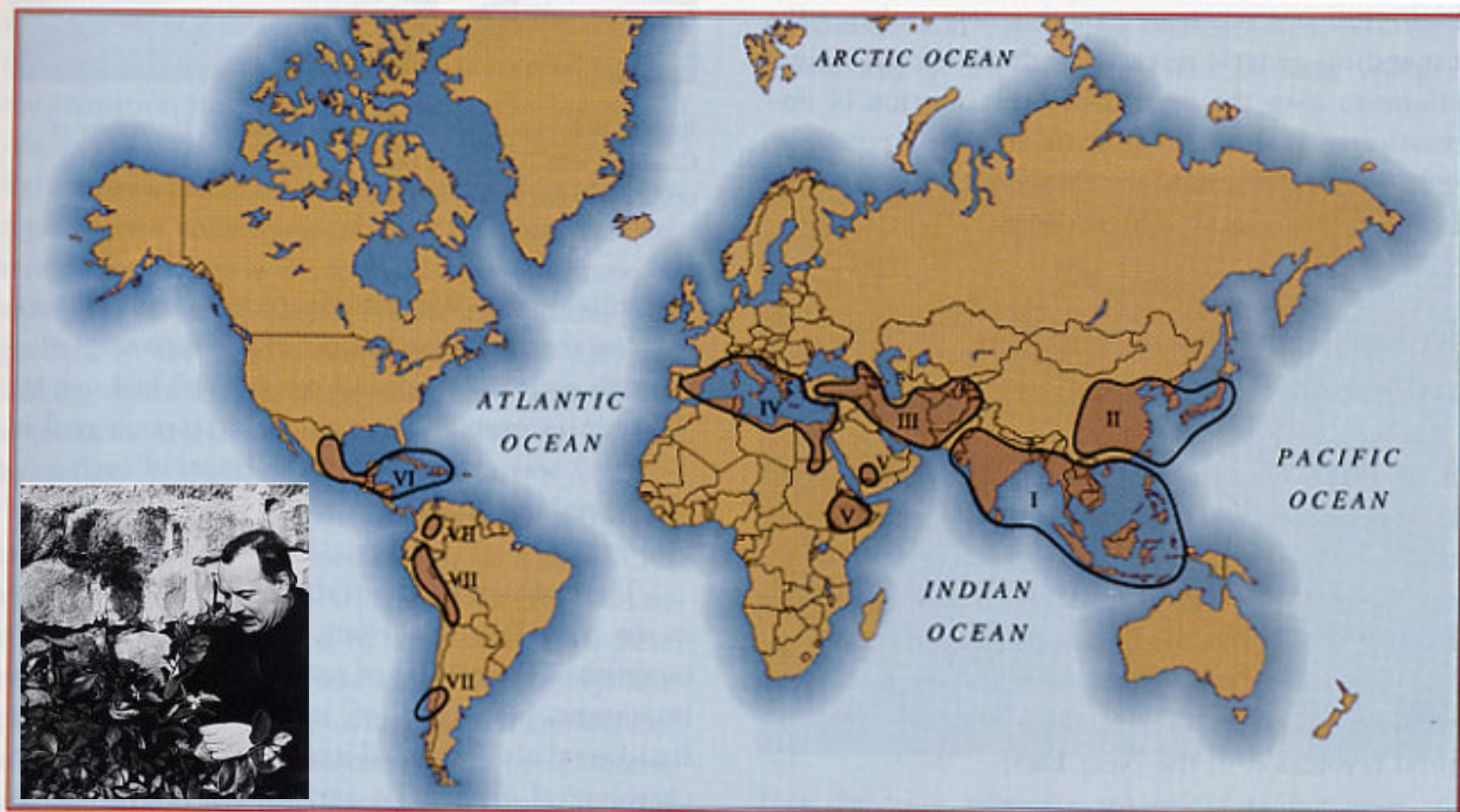


Flannery's: Guilá Naquitz Model

1. Over 2000 Years (10750-8750 BP), hunter-gatherers learn to schedule foraging for different wild resources seasonally.
2. Unpredictable rainfall regime forces local people to maintain institutional memory of alternate (crisis) resources.
3. Try to reduce risk of dry years, by experimenting with planting wild beans during wet (good) years.
4. When successful, manipulation of plants gradually supplants hunting and gathering.

Guilá Naquitz, Oaxaca Valley, Mexico, undergoing excavation in 1966 (© Kent Flannery).

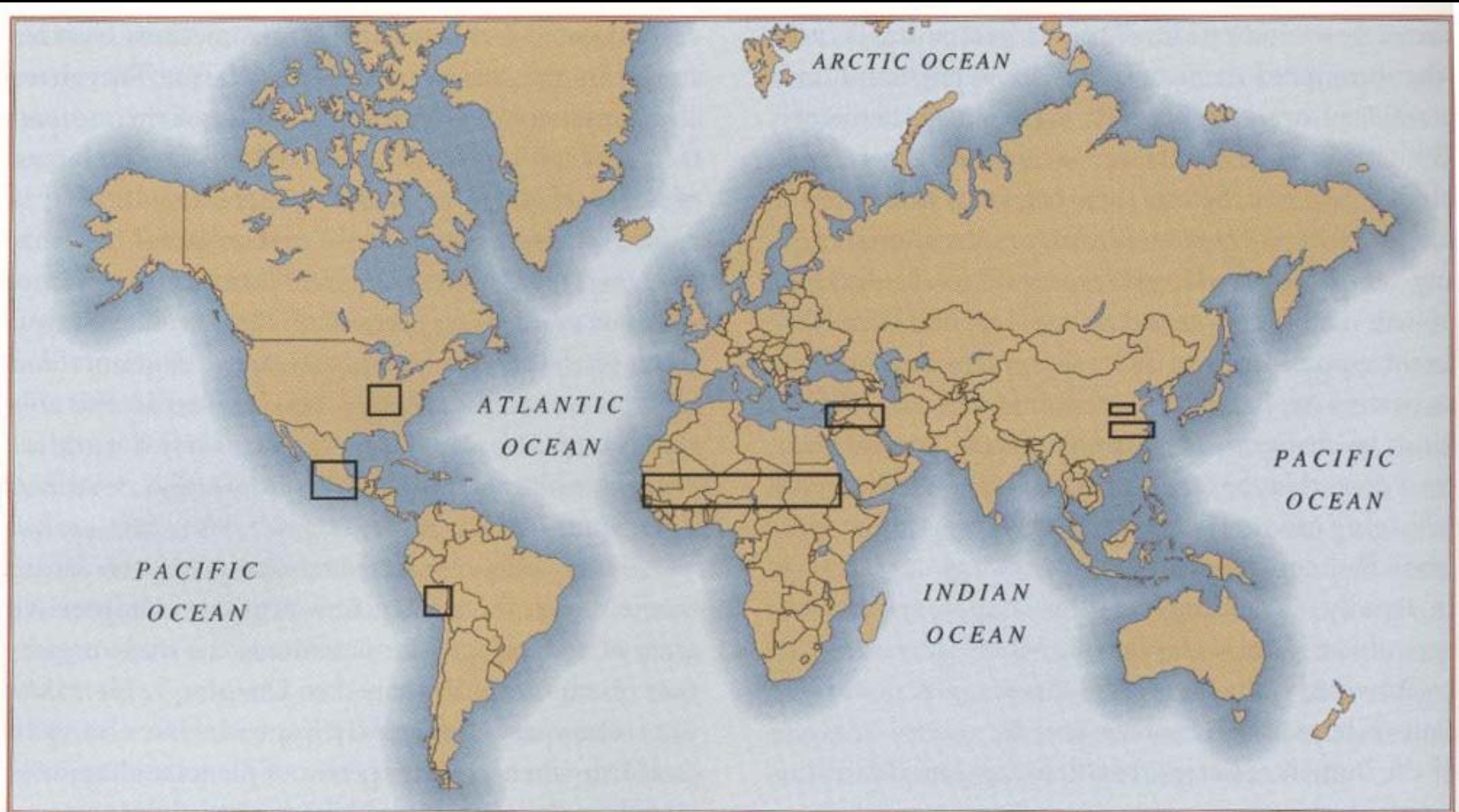
Vavilov's 1940 Hypothesized Agricultural Hearth Areas



Nikolai Vavilov - Russian geneticists who studied plant diversity

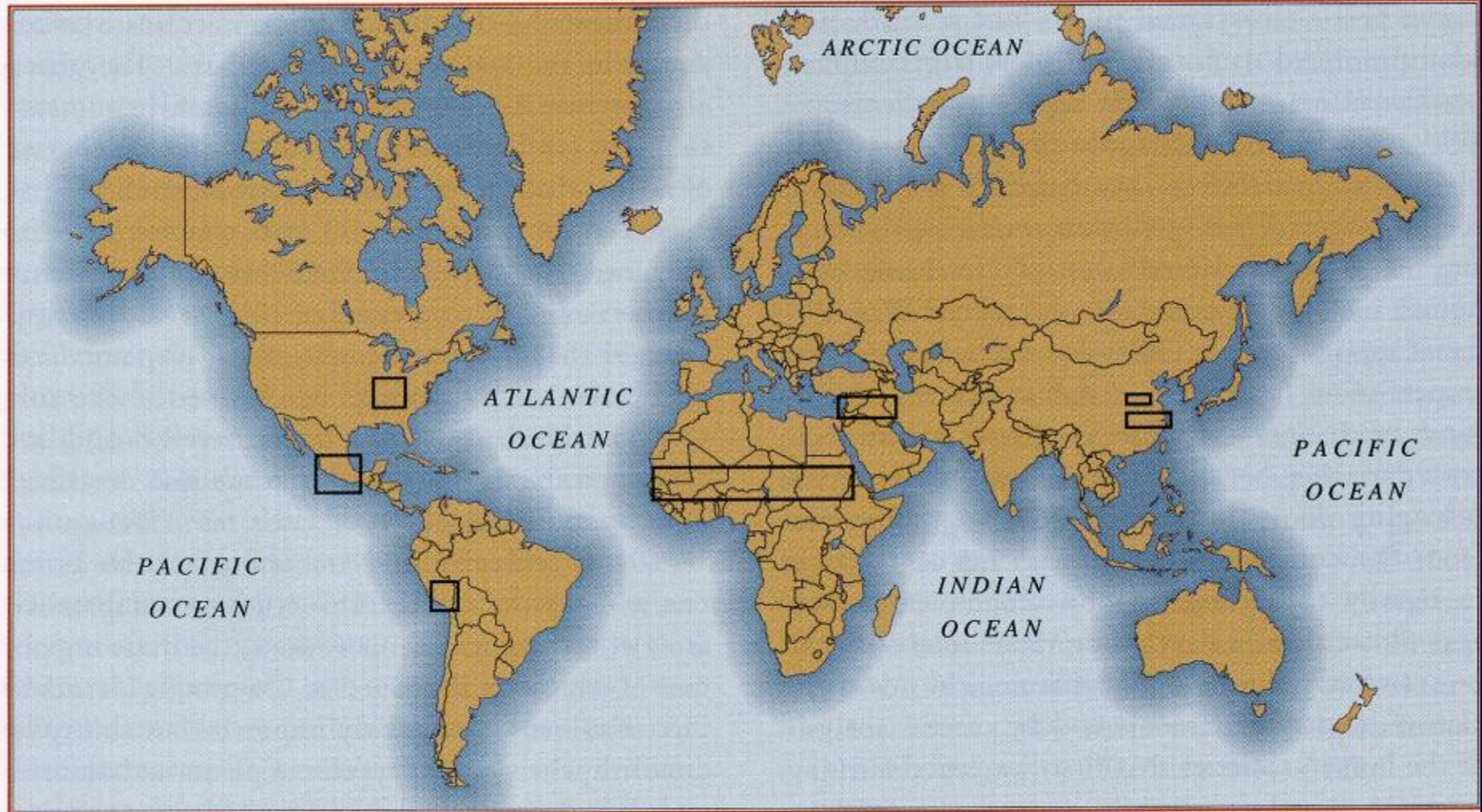
Vavilov's final map, published in 1940, showed seven centers of origin of domesticated plants: I, the tropical south Asiatic center; II, the east Asiatic center; III, the south-western Asiatic center; IV, the Mediterranean center; V, the Abyssinian center; VI, the Central American center; VII, the Andean (South American) center.

Current Hearth Areas for Agricultural Origins



The seven areas of the world where the independent domestication of plants and animals led to the emergence of agriculture.

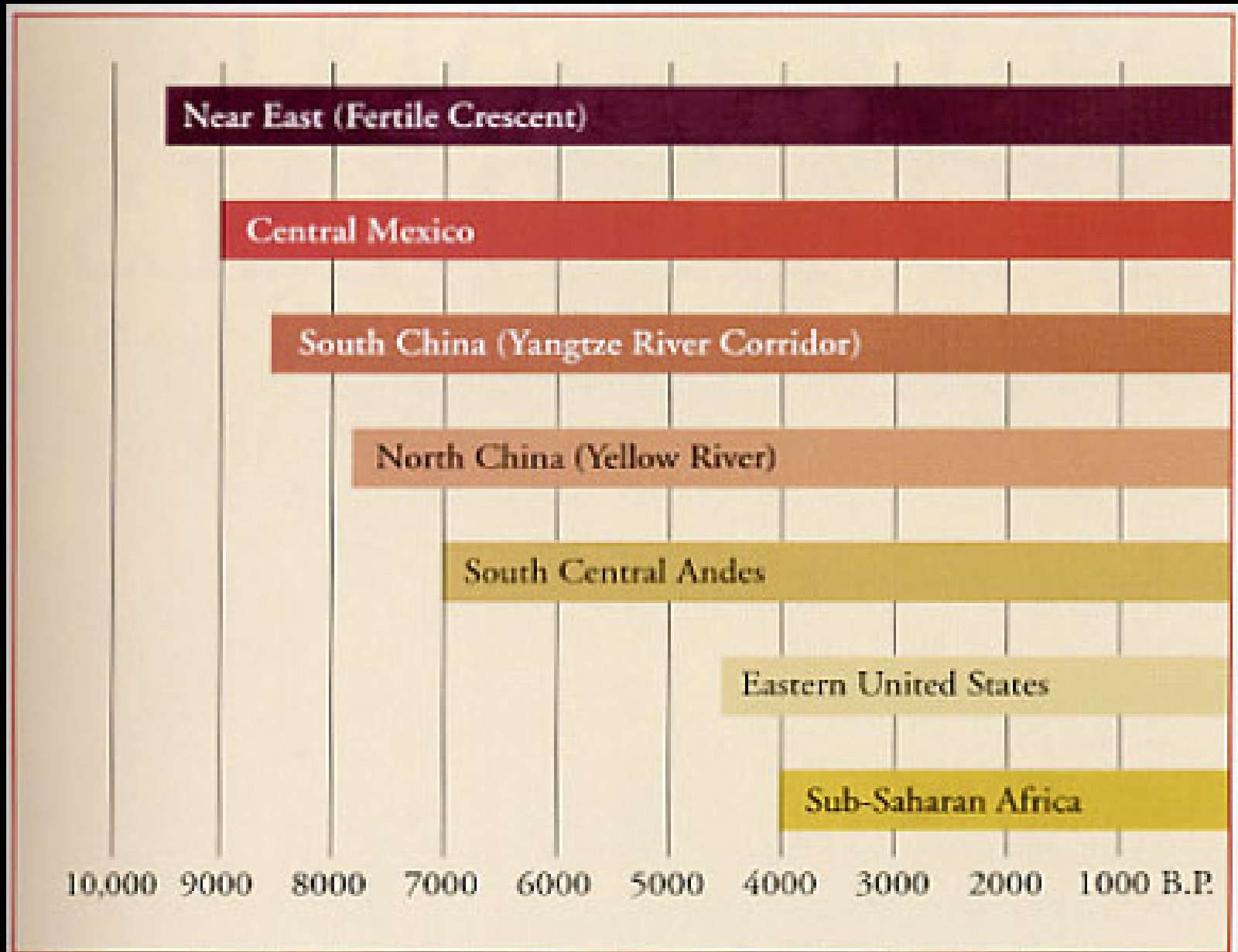
Current Hearth Areas for Agricultural Origins



The seven areas of the world where the independent domestication of plants and animals led to the emergence of agriculture.

*Smith, Bruce (1998)
The Emergence of Agriculture*

Agricultural Origins Around the World

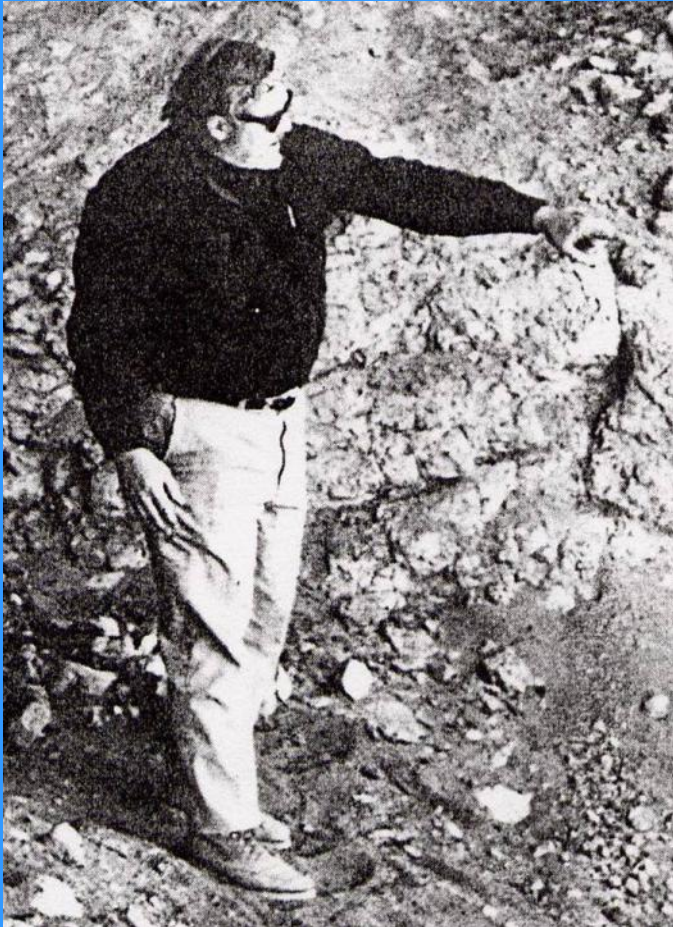


Natural Habitat Hypothesis

- “The food producing revolution seems to have occurred as the culmination of the ever increasing cultural differentiation and specialization of human communities... [People] had come to know their habitat so well that they were beginning to domesticate the plants and animals they had been hunting and gathering.” (Braidwood 1960)

Pull Model – Change following in depth knowledge and creativity. (assumes agric= desirable)

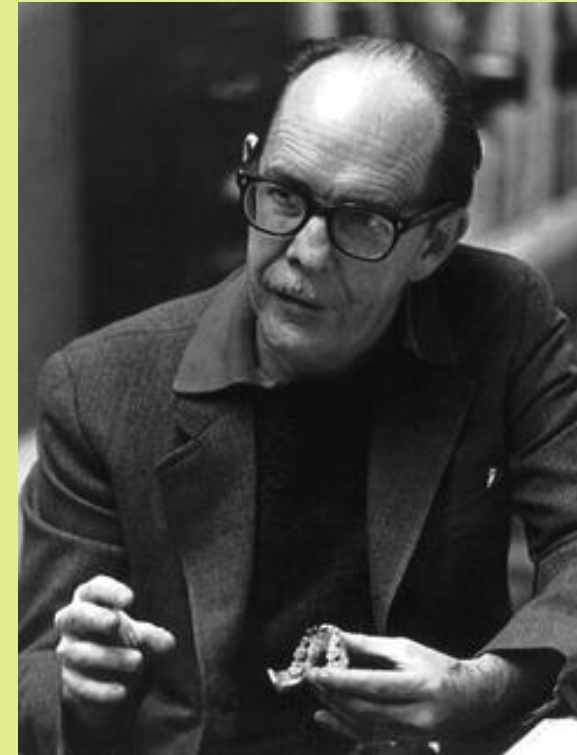
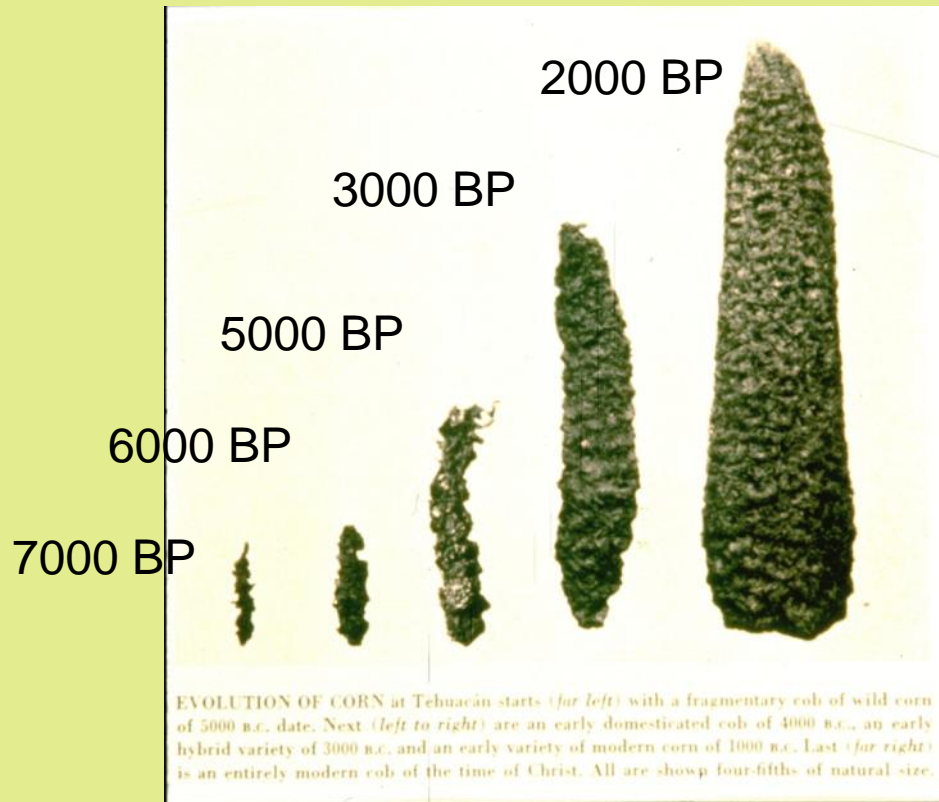
Lewis Binford's Marginal Zone Model



- Population growth in settled fishing communities
- Excess population moves to ecological fringes
- Fringe populations are forced into contact with other populations
- Greater productive capacity would have had adaptive benefits – agriculture could emerge.

Binford 1968

MacNeish's Tehuacan Sequence

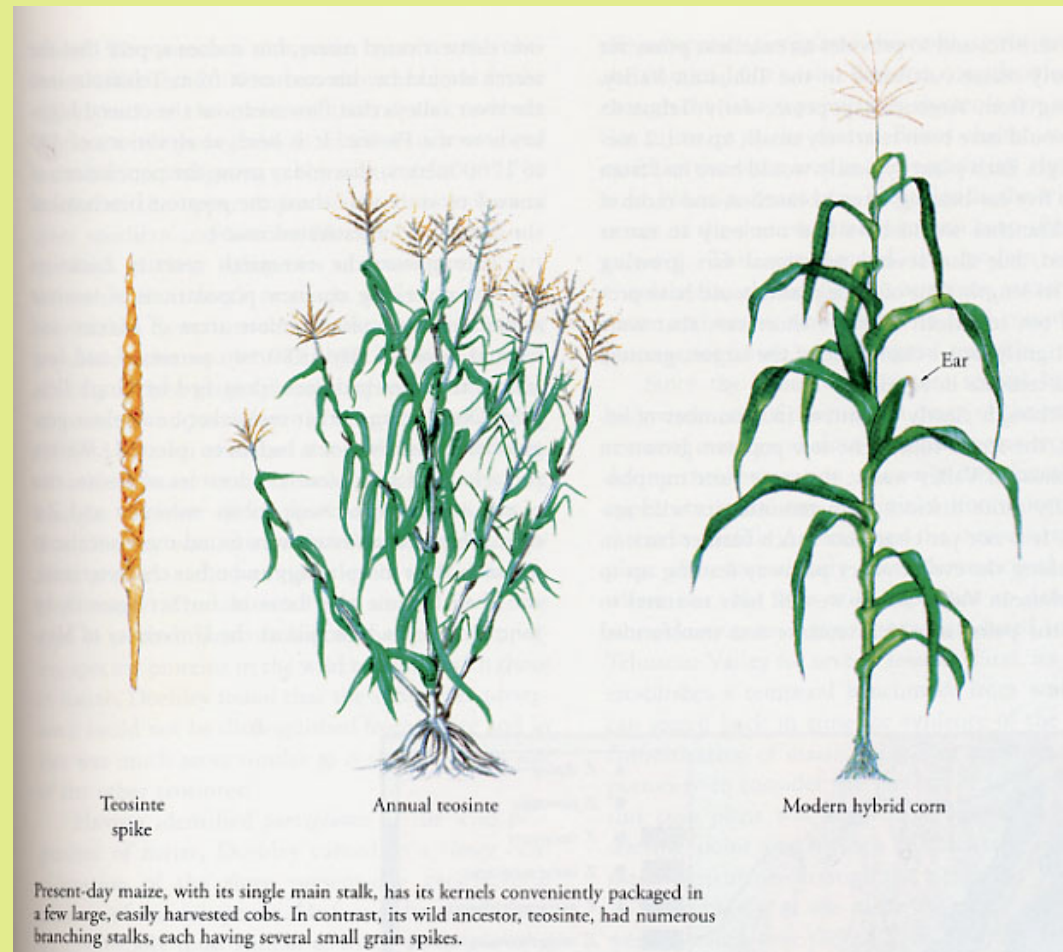


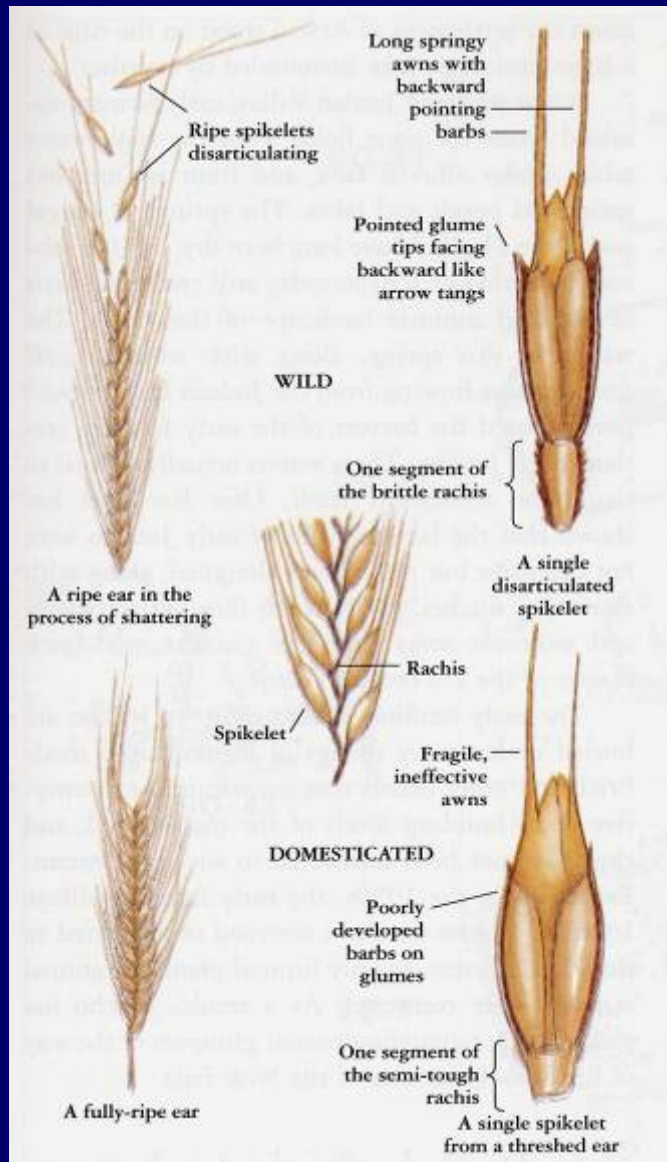
**Dates are no longer valid
(direct AMS dating of cobs
places oldest at ca 4700BP)**

Teosinte and Maize



A seed spike of the wild grass teosinte (left), consisting of a single row of kernels, with each kernel enclosed in a hard shell-like case. On ripening, the spike shatters, scattering the seeds. When teosinte was domesticated, human selection transformed this seed spike into the much larger maize ear (right), which has many more rows of kernels that are not protected by fruit cases and that adhere to the cob rather than dispersing when ripened.





Einkorn Wheat

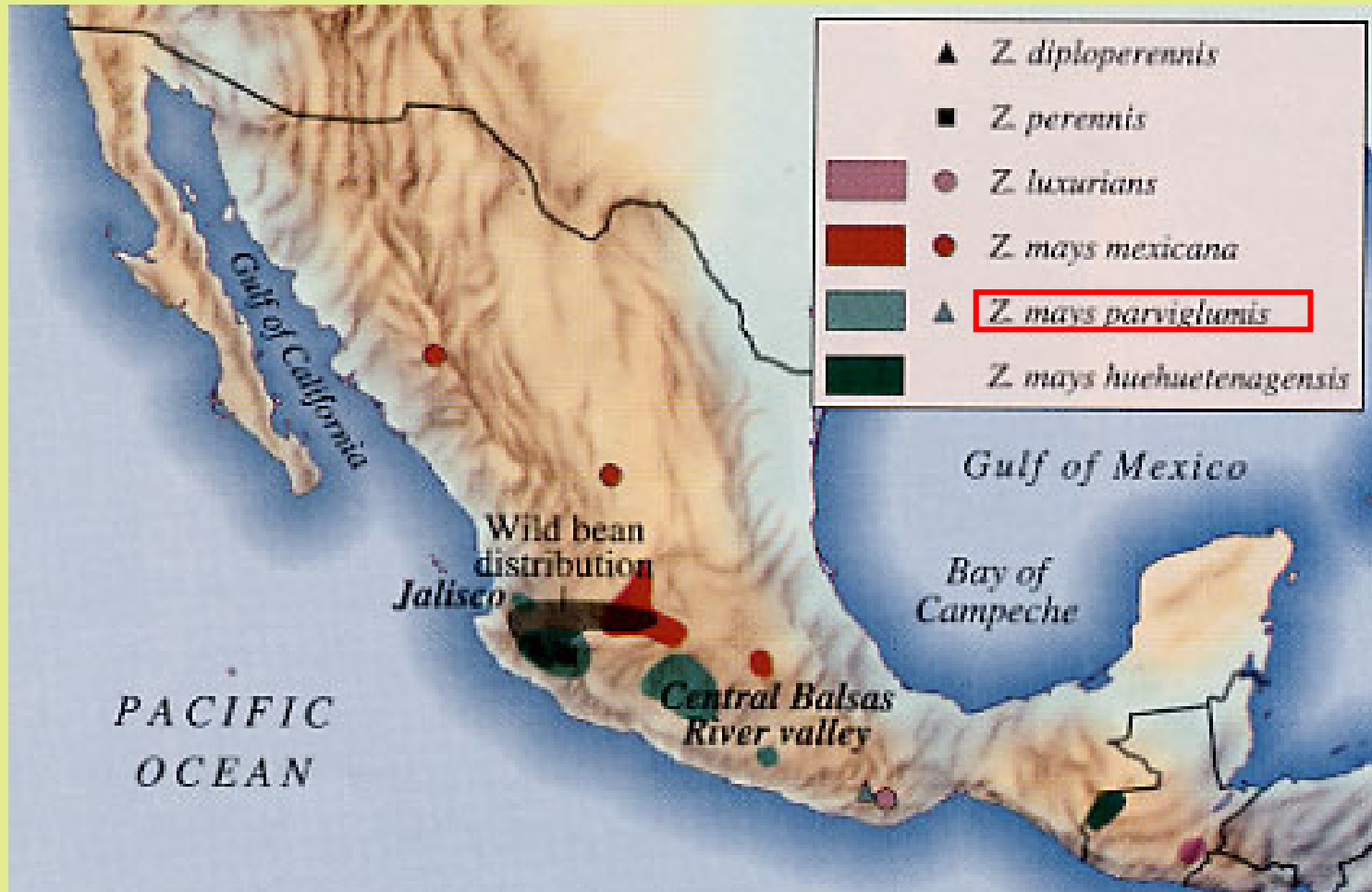


Barley



Stands of the annual teosinte *Zea mays* subsp. *parviglumis* growing in luxuriant hillside settings in the state of Jalisco, Mexico.

Which Teosinte?



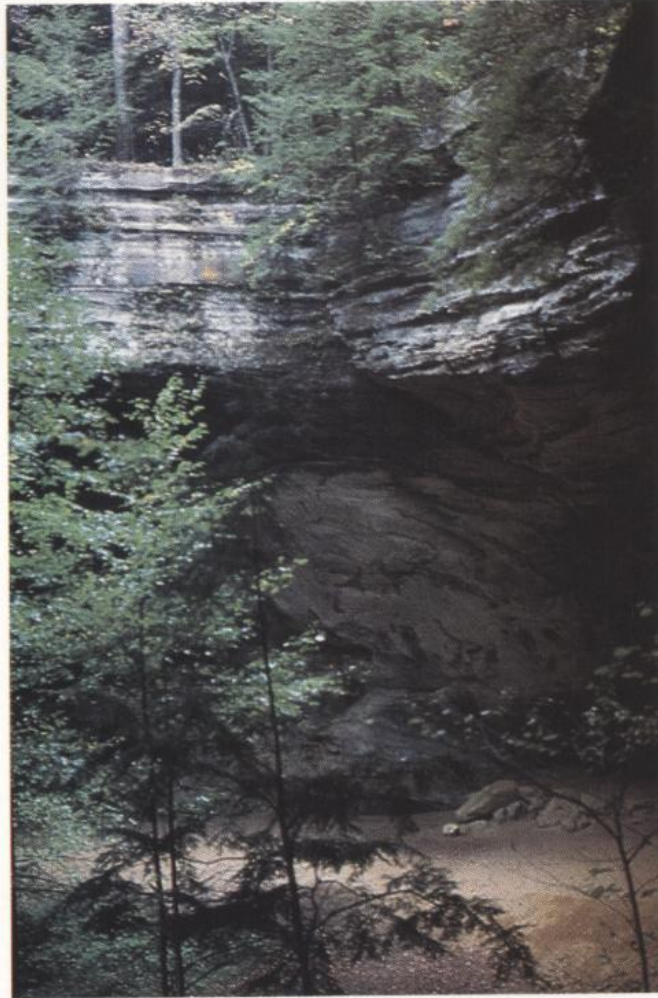
North American Domesticates

- Goosefoot (*Chenopodium berlandieri*)
- Sunflower
- Marsh elder
- Squash
- Tobacco



- Maize arrived in SW – ca. 3200 BP
- Maize arrived to Atlantic Coast ca 2000 BP.

Chenopodium



In 1876 Ebenezer Andrews excavated Ash Cave in south-central Ohio and discovered a 2000-year-old cache of seeds of *Chenopodium berlandieri*, now known to have been one of four plants domesticated in the eastern United States.



This remarkably preserved 2000-year-old woven bag, from the Edens Bluff shelter in the Arkansas Ozarks, is likely to be similar to the one from Marble Bluff shelter found to contain 3000-year-old domesticated *Chenopodium berlandieri* seeds.

Chenopodium



Excavated by C. Wesley Cowan of the Cincinnati Museum of Natural History, Cloudsplitter rock shelter in eastern Kentucky has yielded some of the oldest evidence of domesticated plants in eastern North America.

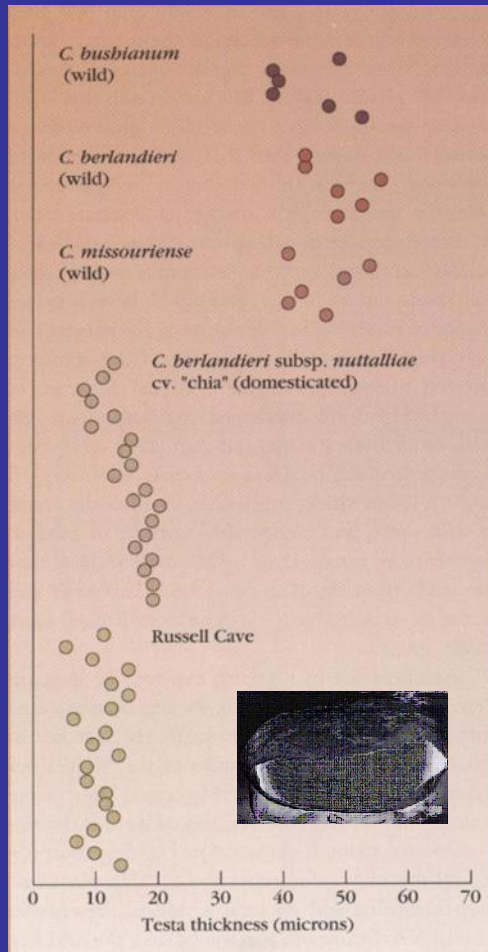
3000 BP domesticates
Marble Bluff Shelter
in Arkansas Ozarks

3500 BP domesticates
Cloudsplitter and
Newt Kash Rockshelters
in Eastern Kentucky

Bruce Smith believes this
domesticate will eventually
date to 4000-4500 BP

Russell Cave

Chenopodium seed coat thickness



Caption:

“Seed coat thickness in wild and domesticated *Chenopodium*. Unlike present-day wild *Chenopodium* species in eastern North America, which have seeds with thick testes (40 to 60 microns), the seeds from Russell Cave have seed coats less than 20 microns thick, comparable to the seed coats of a domesticated variety of *Chenopodium* grown today in Mexico.” (Smith 1998)



The exposed gravel bars and floodplain plant community of Gourd Island, along the Buffalo River in Arkansas, is a typical habitat for the Ozark wild gourd.

Implications for Agricultural origins

- “Ozark wild gourd”, Marsh elder, and Goosefoot are each invasive “weedy” species that falls into rivers and is adapted to river bank flooding.
- All are preadapted to colonizing disturbance zones of human habitation
- All were collected wild prior to 4500 bp
- Bruce Smith sees evidence that climate and stream hydrology between 7000 and 5500 BP led to more productive river valleys compared to uplands.
- This led to an increase in hunter-gatherer sedentism
- Over time, refuse built up, providing perfect habitat for wild gourd, marsh elder and goosefoot

Implications for Agricultural origins

- Sites like Koster, Eva, Black Earth site each suggest substantial populations of sedentary living hunter-gatherers.
- Gradually, accidental seeding of middens would lead to cultivation and weeding.
- Within 50 years of intentional storage of seeds and reseeded/planting in spring, changes in plant phenotypes towards domesticated characteristics would be observed.
- Deliberate planting of at least some species was probably in place by 5000 BP.
- This probably occurred in several valleys throughout the Midwest and East. None appear to have been threatened with population growth, limited resources, or environmental decline.

Implications for Agricultural origins

- So was agriculture the result of “population pressure”
DEFINED as too many people for resources available at a given level of technological sophistication.
- Was it a result of ABSENCE of population pressure?
- Was it a technological innovation (sensu Boserup) in response to Malthusian constraints on population growth?

Original “Slow Food” Movement

Low Level Food Production

- “Mesoamerica, the Near East, and eastern North America are the best-documented primary centers of domestication and subsequent agricultural emergence. And in each of these three areas, where the temporal-developmental placement of both initial domestication and the subsequent transition to agriculture can be determined with a reasonable degree of accuracy, they are separated by large, still mostly uncharted territories stretching across 2000-5500 years of time.”

Bruce Smith 2001. Low Level Food Production. Journal of Archaeological Research, Vol. 9, No. 1 (March 2001), pp. 1-43

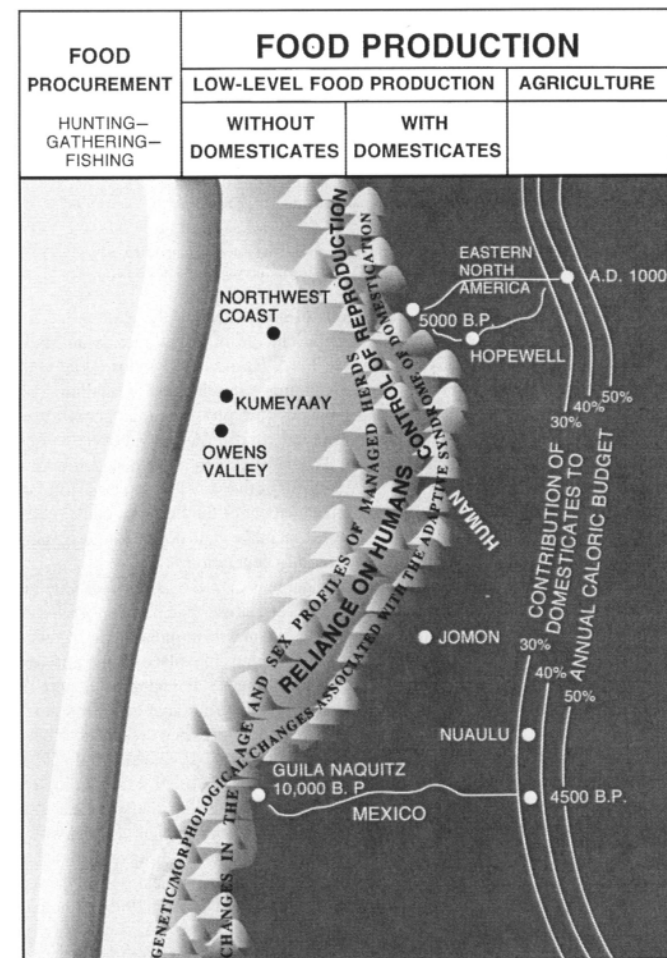
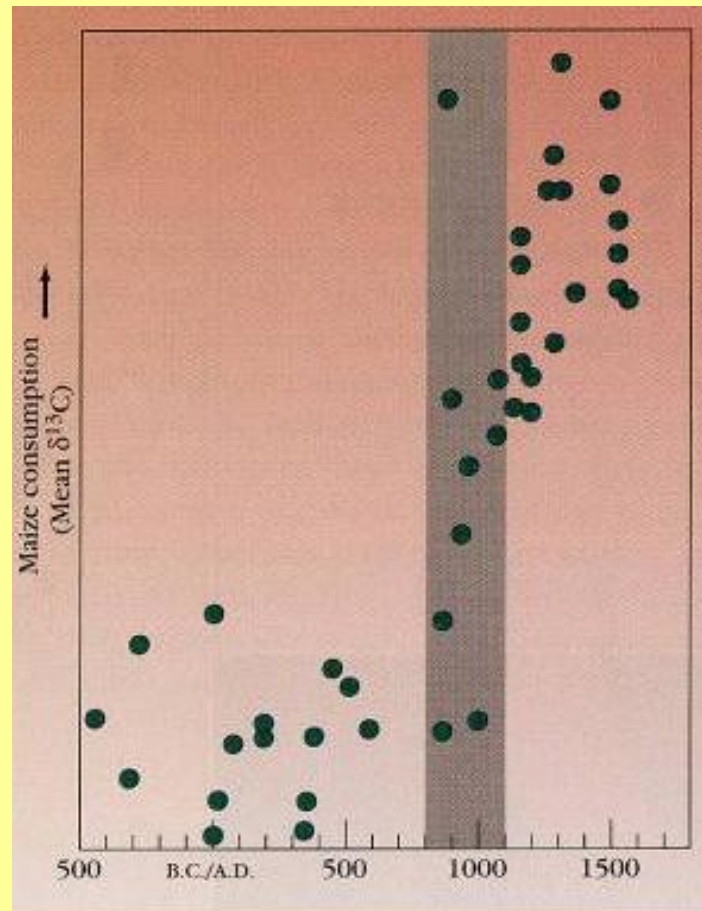


Fig. 7. A conceptual-developmental map of the middle ground between hunting-gathering and agriculture.

High yield Maize adoption in Eastern U.S.

- Maize was known in the Eastern Woodlands area of N. American since at least 2000 years ago.
- Became important as a dietary staple only 900 years ago. Why the delay?



At about A.D. 900, maize became much more important in the diet of agricultural societies from southern Ontario to northern Florida, as shown by the abrupt change in $\delta^{13}\text{C}$ values of human bone.

Discussion Questions

- "In what ways did the transition to managed food production (low level FP and agriculture) set humans on a fundamentally new trajectory, and in what ways not?"
- How did agriculture affect human population growth and health?
- Was it a 'good' thing or a 'bad' thing for human societies and why?
- What are some of the legacies of the turn to food production we live with today?
- In what ways are GMO technologies simply an extension of agricultural intensification? Is GMO food anything new in our agricultural history?
- What arguments would support rejecting GMO vs. embracing it?
- How might control over food production intersect with political dynamics in societies of the past and present?
- What about food production facilitates feeding people? What about food production facilitates manipulating people?
- Is it possible to imagine equality in an agricultural context, and if so, what would be needed? Is it a worthy goal to pursue?"